THE COMBAT CASUALTY CARE MEDICAL INFORMATION SYSTEM (CCC/MIS) PROTOTYPE

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PROTOTYPE

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EXECUTIVE SUMMARY

PROBLEM

Discussions at a technical workshop on combat casualty care held in 1976 indicated that the current method of processing medical data at the forward echelons of treatment were inadequate and it was suggested that automated methods be developed. Subsequent workshops have identified specific functional enhancements which could be integrated into an automated system for combat casualty care.

the **OBJECTIVE** was to

Develop the conceptual design of an automated system that would meet combat casualty care information management requirements to maintain a combat medical history, perform patient tracking and logging functions, and facilitate the continuity of casualty care. ⟶ Cont'd DD1473 (Last page)

APPROACH

A system prototype was developed as a platform for testing program features, functions, and design concepts. Following a typical combat scenario, each of the system's capabilities were exercised and evaluated.

RESULTS

This report describes the Combat Casualty Care Medical Information System prototype in terms of hardware, software, and various functions which are performed during the operation of a field medical company.

CONCLUSIONS

The successful demonstration of the prototype provides strong evidence that a functional field medical data processing system can overcome shortcomings of the current system and increase the productivity of medical personnel by reducing their administrative burden. Potential system enhancements to the proposed operational system are also described and discussed.

BACKGROUND

Automation of combat casualty care data was a topic of discussion at the Technical Workshop on Combat Casualty Care hosted by the Naval Medical Research and Development Command in April 1976.[1] This meeting was followed by a Fleet Marine Force Medical Information Systems Requirements Definition Workshop sponsored by Headquarters, U.S. Marine Corps (MED) and the Naval Medical Research and Development Command in May 1982.[2] During these workshops, needs such as the following were identified:

- The need to maintain complete and accurate medical records in the field.
- The need for medical history information at forward echelons of medical care.
- The need to communicate treatment information quickly and accurately along the evacuation chain.
- The need to rapidly determine the deployability status of Marine Corps personnel.

As a result of the requirements identified, the Commandant of the Marine Corps requested that "research, development, test and evaluation necessary to produce an initial operating capability in support of the Marine Corps be initiated.[3]"

The Naval Health Research Center (NHRC) began such a program by hosting a conference on the Fleet Marine Force Combat Casualty Care Information System[4]. During this conference, an alternative to the Field Medical Card (DD 1380) was proposed and a combat medical record was defined. From information obtained at this conference, system concepts for the Operational Medical Information System (OMIS) were developed.[5,6,7,8,9] Basically, it was concluded that a casualty care system would be organized around a microcomputer or a network of microcomputers at the third echelon of care (the Medical Company). Further, the system would have to operate within the context of related systems such as the Theater Army Medical Management Information System (TAMMIS), the Composite Health Care System (CHCS), and the Shipboard Non-Tactical ADP Program (SNAP). Therefore, it was suggested that a modular design be used, that the system be dictionary driven, and that the method for transferring data among service points be standardized.

To further develop the conceptual design of the Combat Casualty Care Medical Information System (CCC/MIS), work began on a system prototype. The objective of this effort was to address deficiencies identified in the previous workshops, such as:

- Field medical data was frequently lost or not recorded.

- Communication of casualty information between echelons was inadequate.

- Inaccurate or incomplete reporting of casualty information occurred.

- Material inventory and replenishment methods were cumbersome and incomplete.

- Management reports were delayed and often inaccurate.

- The manual data collection system was not responsive in the time and scale required.

This paper describes the prototype system in terms of the hardware configuration, software, and functions performed. The problems encountered during in-house testing are identified, and future plans for enhancements designed to resolve problem areas are discussed.

SYSTEMS ANALYSIS:

In an effort to determine the detailed specifications needed for the prototype, NHRC conducted a rigorous systems analysis of data flows and communication procedures used in training exercises by Marine Corps Medical Personnel at Camp Pendleton, CA[10] Initially, a questionnaire was used by team members as a guide for determining the types of information required at each treatment location within the Medical Company. Once a basic knowledge was gained, team members revisited various key personnel to further isolate data types and transmission modes. After several visits, data flow diagrams were drafted to portray the current procedures (current physical model). Figure 1 is a result of the systems analysis and clearly shows the complexity of the system now in use.

From the systems analysis it was determined that two types of data were being processed at the Medical Company: 1) medical (e.g. injury and treatment information); and 2) administrative (e.g. patient location and resource usage). It was observed that in many cases redundant and/or non-essential data collection was causing personnel to expend more time and effort than necessary to accomplish the
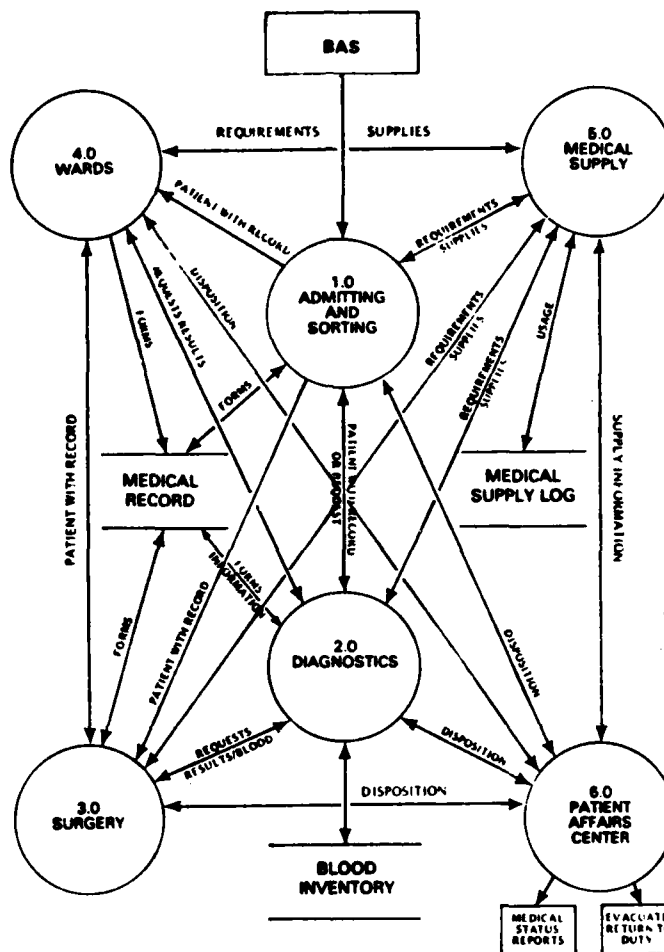
INFORMATION FLOWS IN THE MEDICAL COMPANY

FIGURE 1

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requirements, and finally it was obvious that the hand processing used in the current system was time and labor intensive. The structured analysis at Camp Pendleton showed that at least two people are needed at the Patient Affairs Center to record and transmit data, as well as maintain the various status boards. At each of the approximately 16 treatment or processing areas, at least one person must be responsible for log books and data keeping materials. Each time a patient enters any location or changes status, a hand-kept record must be made noting time, date, patient name, and other identifying information, as well as the status of the patient. On the average, this accounts for about a minute or two of processing time per patient per log entry. For a patient following a typical routine of TRIAGE-ANS-XRAY-PREOP-O.R.-R.R.-Ward with the associated lab work, the accumulated administrative processing time over a typical stay would be about 30 minutes per patient. For a 100-bed facility over a 1-4 day period, this could result in more than 50 man hours being taken for administrative processing time in addition to the two persons in Patient Affairs and the runners carrying verbal and hand-delivered messages. Therefore, there is the equivalent of about 3-1/2 medical personnel who are unavailable for medical care because of their administrative duties.

Based on the estimated time savings, an administrative module was determined to be an essential component of CCC/MIS. A computerized administrative module would perform such functions as the logging in and out of patients to the various treatment locations and use the data to provide status board reports.

CONFIGURATION FOR IN-HOUSE TEST

To emulate the medical company environment, four office spaces at NHRC were used. The two most distant rooms were approximately 100 feet apart. One large room was used to represent Admitting and Sorting, along with Triage. Another large room across the hall was the location of surgery and the wards. One small room represented Patient Affairs-Medical Operations Center while another small room represented the laboratories (see figure 2).

C	COMPUTER WITH MONITOR	
D	DATAKEY READER/WRITER	
B	BAR CODE READER	
T	TERMINAL WITH BAR CODE READER	
G	GRAPHIC DIGITIZER TABLET	

NOTE: ALL FOUR COMPUTERS ARE LINKED
        BY A LOCAL AREA NETWORK (LAN).
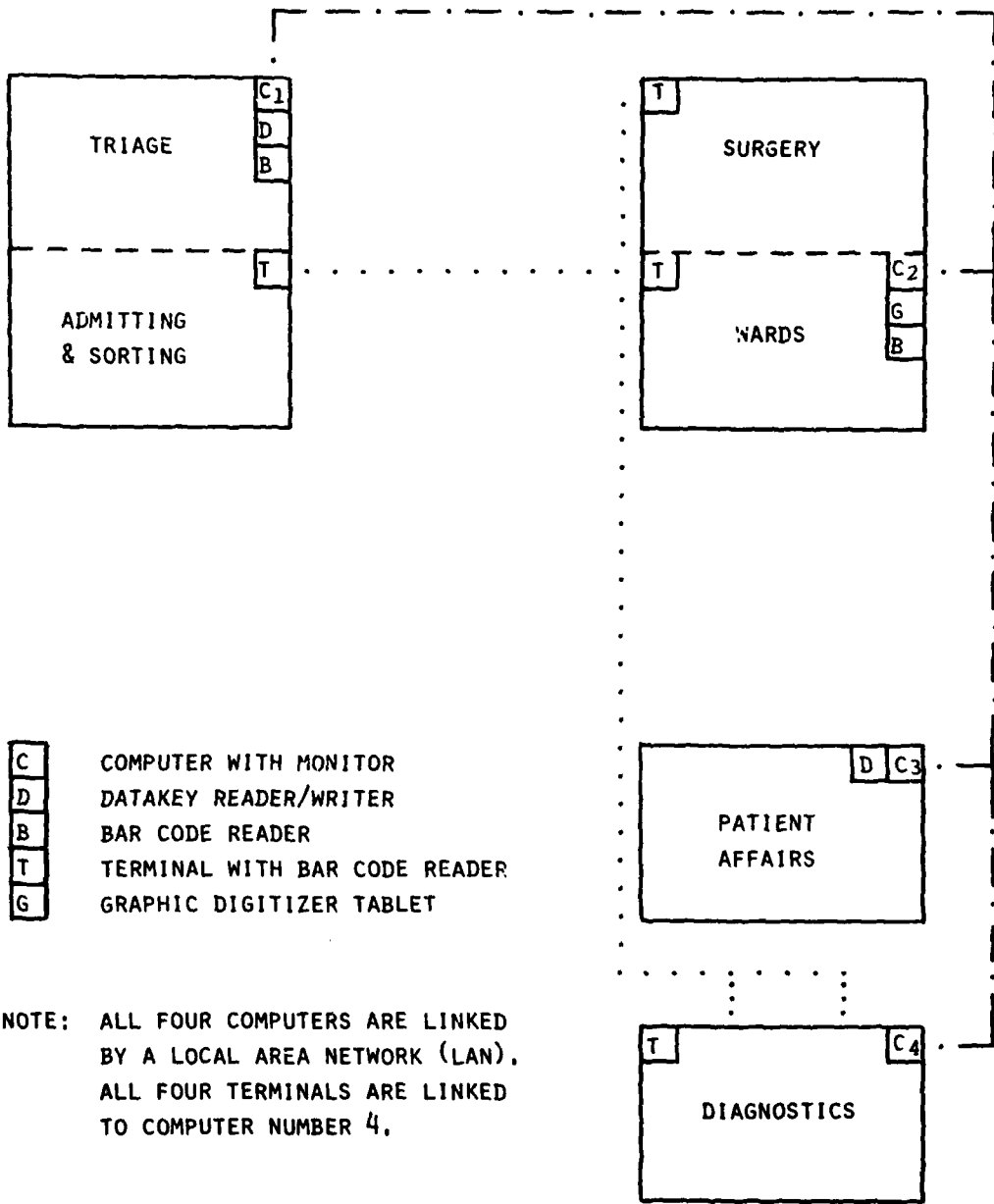   ALL FOUR TERMINALS ARE LINKED
        TO COMPUTER NUMBER 4.

FIGURE 2

<u>Hardware</u>: The rooms representing the Medical Company were linked with computer cabling to allow for the use of a Local Area Network (LAN) to provide sharing of the following resources:

- o four IBM-compatible microcomputers

  - each having 640 KB RAM

  - two with two standard 5-1/4" floppy disk drives

  - two with bubble memory boards (1/2 MB)

  - one containing a 20 MB hard disk and one standard
    5-1/4" floppy disk drive

  - one with a 5 MB removable hard disk and one standard
    5-1/4" floppy disk drive

- o two data key reader/writers with datakeys

- o one graphics digitizer tablet

- o four small two-line bar code terminals

<u>System Software</u>: For the initial software development, DBase III was used for data storage and report generation because of its utility as a rapid prototype development tool. However, the interfaces with the peripheral devices (data key, digitizer tablet, and bar code terminals) *were written in* Turbo Pascal.

Additional software and modifications were necessary for the LAN to function. This network provided the means by which data collected at any treatment location could be shared by any of the four computer locations.

FUNCTIONAL DESIGN

The medical and administrative functions performed by the prototype CCC/MIS are as follows:

- o Patient registration

- o Time/date/location logging

- o Medical information input and storage

- o *Generation of spot status reports*

- o Patient discharge.

Each of these functions are described below.

Patient Registration and Discharge: Every service person is currently required to wear identification tags (dog tags) which contain personal as well as medical information. To demonstrate alternative methods of data storage and entry, a device (datakey) similar in size to a standard identification tag was carried by each casualty and used to store personal and medical information electronically. During patient registration the Datakey belonging to the simulated casualty was placed into a reader (located in the triage area) in response to a computer screen prompt. Data from the key was then merged with a computer generated identification number time and date of registration and triage information supplied by the staff person. At this point the information was stored in a database available for general use by anyone in the system. The following shows the computer prompts given to the staff person in charge of patient registration:

REGISTRATION MENU PROMPT:

Step 1:

COMBAT CASUALTY CARE MEDICAL INFORMATION SYSTEM

TRIAGE AND DISCHARGE STATION

INDICATE IF PATIENT IS ENTERING OR LEAVING? (IN OR OUT)_____

(System waits for user input. If input is "IN", the computer prompts for triage category after assignment of a patient number.)

Step 2:

COMBAT CASUALTY CARE MEDICAL INFORMATION SYSTEM

TRIAGE AND DISCHARGE STATION

THIS PATIENT HAS BEEN ASSIGNED ID NUMBER

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PLEASE INPUT THE TRIAGE CATEGORY (1,2,3,4) FOR THIS PATIENT_____

DOES THIS PATIENT HAVE A DATATAG? (1=YES, 0=NO)_____

(After triage category is entered, the user is asked about the patient's datatag. If the patient does have a datatag, he will be registered and the system will return to the first menu prompt. If patient does not have a data tag one can be generated at that time.)

During the prototype demonstration a patient can only be discharged from the triage area. When a patient is discharged, 'OUT' is entered in Step 1. As a result the following prompts are given to the staff person:

DISCHARGE MENU PROMPTS

Step 1: (System starts here and waits for input.)

COMBAT CASUALTY CARE MEDICAL INFORMATION SYSTEM

TRIAGE AND DISCHARGE STATION

*INDICATE IF PATIENT IS ENTERING OR LEAVING? (IN OR OUT)*_____

(Because patient is checking out, user is asked for patient's ID then disposition.)

Step 2:

PLEASE INPUT THE PATIENT ID NUMBER._____

PLEASE INPUT PATIENT DISPOSITION (RTD OR EVAC)_____

(After input of patient ID and disposition, the full patient identification is displayed)

PATIENT NAME	SSN	TRIAGE	DOB
WILSON	333-33-3333	3	03/03/63

PATIENT NUMBER 23

IS CHECKING OUT AT

12:55:04

09/20/86

FOR EVAC

(The system then returns to the first menu prompt.)

It should be noted that at each data entry point the staff person has the option of using a keyboard entry, a bar code pen, or datakey as appropriate. These options speed up data entry as well as greatly reducing the chance of error.

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Medical Information: To again demonstrate the utility of alternate data input mechanisms, a proposed replacement for the Field Medical Card (DD1380) was used to represent combat casualty data supplied by a corpsman. This form, printed on mylar, is virtually indestructable and makes use of body charts and checklists to record injuries and treatments (see figure 3).

A Graphics Digitizer Tablet is used as the data input device for this information. This is an automated input device which is programmed using grid coordinates to accept specific data when contact is made at specific locations on the tablet with a stylus. The form is placed on the tablet into pre-set location pins and the stylus (a pen-type device) is used to point to the body parts which have been wounded and treated. Touching the marked points sends a coded message to the attached computer where the data is decoded and stored for future reference. A simple menu prompt is displayed on the computer screen for the user to follow. This procedure is very simple, making it possible to use non-medical personnel such as walking wounded to operate it. After the data from this form is entered into the computer, the form can be kept in the patient's medical folder along with other documents.

Log Functions: It was observed during the systems analysis that virtually every treatment location within the medical company required a log entry for each patient. Making these entries is often disruptive, time consuming, and frustrating, since much of the information is redundant and of dubious accuracy. Each log entry, besides identifying the patient, requires time, date, location, and possibly additional data. On the average, the logging procedure takes one or two minutes per patient per location, which can consume many hours per day when dealing with close to a hundred patients.

During the prototype demonstration, the logging functions were handled through the use of bar codes and bar code readers. Bar coded labels containing a unique patient number were applied to patient wrist bands upon entry to the simulated medical company when the patient was registered. A bar coded response pad was also located at each logging area (see figure 4). Every time a patient changed location, the wrist band was read with a bar code reader, and when appropriate additional information was prompted for by the small bar code termi-

PATIENT MANAGEMENT

TREATMENT FACILITY	FIELD CORPSMAN		BATTALION AID STA		MED/HOSP CO		FLEET HOSPITAL	
	Date	Time	Date	Time	Date	Time	Date	Time
ARRIVED								
	Date	Time	Date	Time	Date	Time	Date	Time
TREATMENT								

VITAL SIGNS

DATE	TIME	TEMP	PULSE	BLOOD PRESSURE SYS / DIAS	RESP RATE	RESP EXPAN	CAP REFILL	EYE OPEN	VERBAL RESPON	MOTOR RESPON
				( )/						
				( )/						
				( )/						

INJURIES

TYPE OF INJURY

1. DISLOCATION
2. FRACTURE
3. LACERATION
4. PUNCTURE
5. TRAUM AMPUTATION
6. WOUND
7. CONCUSSION
8. WHITE PHOS BURN
9. OTHER BURN
10. OTHER INJ

BURN

1. _____ %
2. _____ %
3. _____ %

TREATMENTS

1. BANDAGE
2. TOURNIQUET
3. SPLINT
4. APPLY HEMOSTAT
5. TRACHEOTOMY
6. SUTURES
7. OXYGEN
8. DECONTAMINATION
9. CAST
10. OTHER

TUBES

1. ENDOTRACH
2. CHEST
3. NG
4. FOLEY CATH

ANESTHETICS

REGIONAL

1. SADDLE BLOCK
2. EPIDURAL
3. AXILLARY
4. IV

FIELD

1. XYLOCAINE
   A. W/EPI
   B. W/O EPI

Figure 3

FIGURE 4

BAR CODED RESPONSE PAD

nals located at each treatment area. This logging process generally did not take
more than 15 to 20 seconds. The patient identification number, after being passed
to the computer, was supplemented with computer generated time, date and location
and stored in a generally accessible data base.

Spot Status Reports: The Patient Affairs Center is the information center
for the Medical Company and is the place where all of the Spot Status Reports are
generated. During the demonstration, updated reports were generated by computer
in roughly 5 minute intervals and required no human intervention or monitoring.
As each report was generated it was placed on the computer screen for a minute or
so in a continuous flow. The spot status reports demonstrated were:

- o Patients currently in treatment
- o Patients previously discharged
- o Blood use and availability (shown below)
- o Current patient locations
- o Number of patients regsitered each of the last 4 days
- o Bedtypes available and in use (shown below)

TYPICAL SPOT STATUS REPORTS

BLOOD STATUS REPORT:

BLOODTYPE	ONHAND	INITIAL	RECEIVED	USED	EXPECTED
A+	100	100	0	0	0
A-	100	100	0	0	0
AB+	100	100	0	0	0
AB-	100	100	0	0	0
B+	97	100	0	3	0
B-	100	100	0	0	0
O+	100	100	0	0	0
O-	200	200	0	0	0
PLASMA	500	500	0	0	0

BED STATUS REPORT:

BEDTYPE	AVAILABLE	COUNT
AMB	24	1
KIA	20	0
MIM	50	0
NBC	1	0
OPG	10	0
SBN	20	0
SCI	5	0
SGS	73	2
SMF	5	0
SNS	5	0
SOP	5	0
SOR	5	0
STH	5	0
SUR	10	

CONCLUSION:

The prototype demonstration showed that automation of medical and administrative functions has the potential of greatly reducing the administrative burden on medical personnel during combat situations. Because of the structuring of certain types of data gathering processes, accuracy can be increased and non-medical personnel such as the walking wounded can be used as data entry personnel. Furthermore, once the data is stored in an electronic database, status reports documenting patient flows which are difficult to compile manually can be readily generated.

Although the software and hardware were successfully integrated and the various functions were demonstated, the demonstration did reveal areas of the system that should be improved prior to a field test. In the area of hardware, the Bar Code Terminal devices proved to be the most troublesome piece of equipment. These required an inordinant amount of special programming to become integrated into the system. The IBM compatible computers which were used posed another hardware problem. They frequently failed and the manufacturer's support

for this equipment was less than adequate. In the area of software, DBase III is a proprietary database management package with limited device handling capability. Finally, it could not be determined whether it was the hardware or the software aspect of the LAN that made it difficult to work with. However, other more well-behaved systems are available.

FUTURE EFFORTS

Future efforts will be directed toward the resolution of the problem areas identified and the development of a system suitable for testing in a field environment. To resolve the hardware problems, the Bar Code Terminals will be replaced with hand-held microcomputers with a built-in bar code reader. The existing computers will be replaced. A new software environment will be explored in which VA Filemanager software, a government-developed database management package, will be used for database management. With regard to problems with the LAN, two solutions will be pursued. First, a new, more sophisticated network will be tested. This has the advantage of hardware redundancy. Thus, if one micro-computer malfunctions, operations can continue on the other three. However, the additional overhead of network boards, software, and cabling leads to the consideration of the second solution, a multi-user system configuration. This configuration will be based upon a host computer which maintains a central database and ultimately controls all peripheral devices. A system such as the one in figure 5 is potentially easier to maintain and, if a journalling capability can be developed, may prove to be sufficiently reliable to be the host for the CCC/MIS.

In addition to resolving problems identified during in-house testing, CCC/MIS will be enhanced in a variety of ways prior to field testing. First, the outputs will be expanded. For example, current status reports will contain more types of information and new status reports will be developed. A printer will be used to output these reports in a hard-copy format. In addition, the potential use of mouse systems, touch screens, and voice recognition devices will be evaluated. Also, various output devices such as voice synthesizers will be tested. Depending upon the results, these devices may be included in the planned field test. Finally, a digital communication capability betwen the Medical Company system and rear echelons will be incorporated into CCC/MIS.
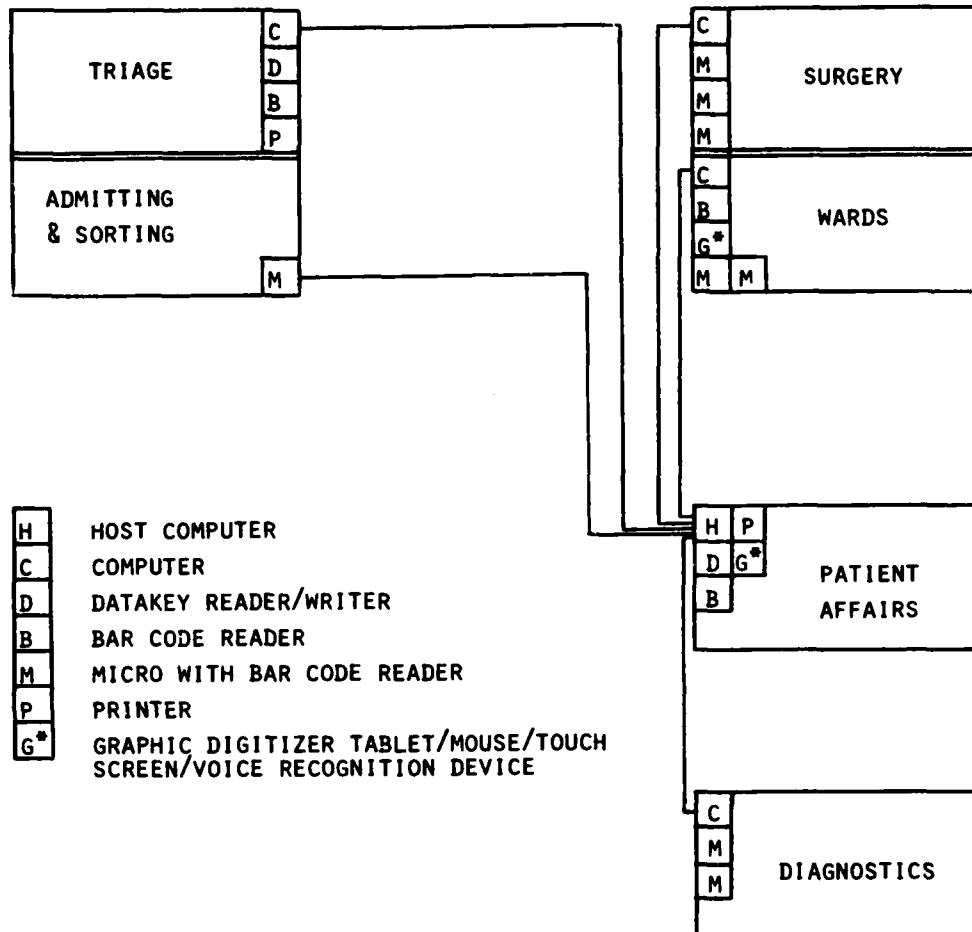
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FIGURE 5

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

A prototype of a Combat Casualty Care Medical Information System (CCC/MIS) was developed and demonstrated by the Naval Health Research Center for the Marine Corps. The system utilized micro-computers and various pieces of peripheral equipment linked together by a Local Area Network (LAN). The specially developed software allowed the system to perform functions which addressed issues identified through a rigorous systems analysis of Fleet Marine Force medical data collection procedures during combat conditions.

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